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DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

Attorney Docket No. 01222

U.S. Application No. (if known,
see 37 CFR 1.53(f))

09/926727

INTERNATIONAL APPLICATION NO.
PCT/NO00/00208INTERNATIONAL FILING DATE
June 15, 2000PRIORITY DATE CLAIMED
June 15, 1999

TITLE OF INVENTION

METHOD AND APPARATUS FOR INTERROGATION OF BIREFRINGENT FBG SENSORS

APPLICANT(S) FOR DO/EO/US

Jon Thomas Kringlebotn

Applicant herewith submits to the United States Designated Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (only if not required by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ As assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
 ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:



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PATENT TRADEMARK OFFICE

09/926727

JC13 Rec'd PCT/PTO 10 DEC 2001

17. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a)(1)-(5):					
Neither international preliminary examination fee (37 CFR 1.482)					
Nor international search fee (37 CFR 1.445(a)(2) paid to USPTO					
And International Search Report not prepared by EPO or JPO..... \$1,040.00					
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by EPO or JPO.....\$890.00					
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International search fee (37 CFR 1.445(a)(2)) paid to USPTO..... \$740.00					
International preliminary examination fee paid to USPTO (37 CFR 1.482) But all claims did not satisfy provisions of PCT Article 33(1)-(4).....\$710.00					
International preliminary examination fee paid to USPTO (37 CFR 1.482) And all claims satisfied provisions of PCT Article 33(1)-(4)..... \$100.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$1040.00	
Surcharge of \$130.00 for furnishing oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total Claims	10 -20=		X \$18.00	\$	
Independent Claims	3 -3=		X \$84.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				\$	
TOTAL OF ABOVE CALCULATIONS =				\$1170.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				\$585.00	
SUBTOTAL =				\$585.00	
Processing fee of \$130.00 for furnishing English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$585.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31).				\$	
TOTAL FEES ENCLOSED =				\$585.00	
				Amount to be refunded:	\$
				charged:	\$

- a. ☐ A check in the amount of \$ to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. 04-0753 in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 04-0753. A duplicate copy of this sheet is enclosed.
- d. ☒ A payment of \$ 585.00 is made by credit card. A Credit Card Payment Form (PTO-2038) is attached hereto. The Commissioner is hereby authorized to charge payment of any additional filing fees required under 37 CFR 1.16 or any patent application processing fees under 37 CFR 1.17, or credit any over payment to the credit card account shown on the attached Credit Card Payment Form. Refund of all amounts overpaid, including those of twenty-five dollars or less, is specifically requested. Any fees not accepted by the credit card shown on Form PTO-2038 may be charged to Deposit Account No. 04-0753.

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Ira J. Schultz

NAME

28666

REGISTRATION NUMBER

Dkt. 01222

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of: Group Art Unit:
JON THOMAS KRINGLEBOTN Examiner:

Serial No.: US National Phase of
PCT/NO00/00208

Filed: concurrently herewith

For: METHOD AND APPARATUS FOR INTERROGATION
OF BIREFRINGENT FBG SENSORS

PRELIMINARY AMENDMENT

Honorable Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Before calculation of the filing fee, please amend the
above-identified application as follows:

IN THE CLAIMS:

Please examine claims 1-10 found on Amended Sheets 8, 9
and 10 attached hereto.

Respectfully submitted,



Ira J. Schultz
Registration No. 28666

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AU 625

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JC13 Rec'd PCT/PTO 10 DEC 2001

WO 00/77562

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PCT/NO00/00208

1

Method and apparatus for interrogation of birefringent FBG sensors**Background**

This invention relates to a practical method for accurate and high-resolution measurements of the orthogonally polarised reflected Bragg wavelengths from fibre Bragg grating (FBG) sensors with birefringence. A fibre Bragg grating (FBG) is a permanent, periodic refractive index modulation in the core of a single-mode optical silica glass fibre over a length of typically 1-100 mm, formed by transversely illuminating the fibre with a periodic interference pattern generated by ultra-violet laser light, e.g. from an Eximer laser, either by using a two-beam interferometer, as disclosed by G. Meltz *et al.* in ["Formation of Bragg gratings in optical fiber by a transverse holographic method," Opt. Lett., Vol. 14, pp. 823-825, 1989,] or by illuminating the fibre through a periodic phase mask, as disclosed by K.O. Hill *et al.* in ["Bragg gratings fabricated in monomode photosensitive optical fiber by UV exposure through a phase-mask," Appl. Phys. Lett., Vol. 62, pp. 1035-1037, 1993.] An FBG reflects light within a narrow bandwidth, centred at the Bragg wavelength, $\lambda_B = 2n_{eff}\Lambda$, where n_{eff} is the effective refractive index seen by the light propagating in the fibre, and Λ is the physical period of the refractive index modulation. Outside the FBG bandwidth light will pass with negligible loss. If the fibre is birefringent the refractive index seen by light propagating in the two orthogonal polarisation eigenstates of the fibre, n_x and n_y , will be different. Consequently, there will be two orthogonally polarised reflected spectra from the FBG with two Bragg wavelengths with a wavelength separation of $\Delta\lambda_B = 2B\Lambda$, where $B = n_x - n_y$ ($n_x > n_y$). Some birefringence can also be UV-induced through the writing of the grating.

It is known that the reflected Bragg wavelength from an FBG will change with any external perturbation which changes the effective refractive index seen by the propagating light and/or the physical grating period (fibre length), such as temperature and strain. By measuring the reflected Bragg wavelength, using for example a broadband light source and a spectrometer, an FBG can be used as a sensor for measuring such external perturbations. The bandwidth of the reflection spectrum from an FBG sensor is typically 0.1-0.3nm (~10-30GHz).

An external perturbation can also change the birefringence in the fibre, and hence change the wavelength separation between the two orthogonally polarised reflection spectra. This can be

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WO 00/77562

PCT/NO00/00208

2

exploited to make a sensor where the wavelength splitting is a measure of an external perturbation, such as temperature, strain, or pressure, which directly or indirectly induces extra birefringence in the fibre. Such a sensor can also allow simultaneous measurement of two measurands, such as temperature and pressure/strain, by measuring both the wavelength splitting and the absolute wavelengths (or average wavelength). Various birefringent FBG sensors are disclosed in [US Patent No. 5,399,854 to Dunphy *et.al.*, US Patents nos. 5,591,965, 5,828,059, 5,869,835, all to Eric Udd, and US Patent no. 5,841,131 to Schroeder and Udd), and in [Sudo, M. *et.al.*, "Simultaneous measurement of temperature and strain using PANDA fiber grating", Proc. 12th International Conf. on Optical Fiber Sensors," p. 170-173, 1997].

Interrogation of birefringent FBG sensors has been based on using sensors with sufficient birefringence to cause a splitting of the two reflection peaks which can be resolved by the interrogating spectrometer.

It is known that one or several reflected FBG sensor wavelengths can be measured using a broadband source, for example an edge-light-emitting diode (ELED) or a superfluorescent fibre source (SFS), in combination with a tuneable optical filter, for example a piezoelectric transducer (PZT) tuneable fibre Fabry-Perot filter [Kersey, A.D. *et.al.*, "Multiplexed fiber Bragg grating strain-sensor system with a fiber Fabry-Perot wavelength filter", Optics Letters, Vol. 18, pp. 1370-1372, 1993], or alternatively a tuneable laser source [US Patent no. 5,401,956 (Mar. 28, 1995)], provided the source spectrum covers all possible FBG sensor wavelengths.

To obtain accurate, repeatable wavelength measurements with these techniques one can use a reference scheme based on the use of a fixed Fabry-Perot filter and a reference FBG with separate detector channels [Norwegian patent No 307357]. There are also various other techniques for wavelength interrogation of FBG sensors with broad band sources, such as edge filtering, interferometric detection and direct spectroscopic detection [Kersey, A.D., *et.al.*, "Progress towards the development of practical fiber Bragg grating instrumentation systems," Proc. SPIE, Vol. 2839, 1996].

With standard low-birefringent FBG sensors, inherent or induced birefringence can result in measurement errors caused by the corresponding splitting of the orthogonally polarised FBG reflection spectra. Unwanted birefringence can for example be induced when FBG sensors are embedded in a composite structure. Normally, this splitting is smaller than the reflection

WO 00/77562

PCT/NO00/00208

3

- bandwidth of the FBG. In an interrogation system with a partly polarised source such as an ELED or a polarised tuneable laser, and/or polarisation dependent components, the randomly varying birefringence in the lead fibres between the readout instrumentation and the sensors will cause variations in the relative reflected power in each of the two orthogonal FBG spectra, and hence variations/errors in the measured Bragg wavelengths. Polarisation scrambling techniques have been demonstrated which reduces these birefringence induced measurement errors [Ecke, W., *et. al.*, "Improvement of the stability of fiber grating interrogation systems using active and passive polarization scrambling devices", Proc. 12th International Conf. on Optical Fiber Sensors," p. 484-487, 1997]. Alternatively, one can use an unpolarised source such as an SFS and a system with no polarisation dependent components. However, if the wavelength splitting due to birefringence in the FBG sensor occasionally becomes large enough to significantly change the spectra shape of the reflected spectrum or cause two resolved separate peaks this can give problems for the readout instrumentation and give erroneous results.
- 15 Birefringent FBG based two polarisation fibre laser sensors, as disclosed with a distributed feedback (DFB) fibre laser in the Norwegian patent No. 302441 to J. T. Kringlebotn, are attractive for high resolution measurements of birefringence inducing measurands. The laser light at the two orthogonally polarised eigenstates of the laser are mixed in a detector, generating an electrical beat frequency which is a measure of the birefringence induced in the laser sensor by the measurand.
- 20

Objects

- The main object of the invention is to provide a method for accurate and high-resolution measurements of the orthogonally polarised maximum and minimum reflected Bragg wavelengths from fibre Bragg grating (FBG) sensors with birefringence, using a Bragg wavelength read-out system based on a broadband source or alternatively a tuneable laser source. The aim is to provide a readout system which can measure birefringence-induced splitting of Bragg wavelengths with high resolution and accuracy (ca. 1pm), independently of the magnitude of the splitting. A splitting larger than the FBG bandwidth will hence not be required.
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WO 00/77562

PCT/NO00/00208

4

A second objective is to provide a means for eliminating errors in FBG sensor measurements caused by the grating birefringence in combination with an interrogation system with a partly or fully polarised source and/or polarisation dependent components, independently of the magnitude of grating birefringence and degree of source polarisation.

- 5 A third objective is to provide a means for eliminating signal fading and optimise the signal amplitude of birefringent FBG based two polarisation fibre laser sensors.

Invention

The object of the invention is achieved with a method having features as stated in the
10 characterising part of Claim 1. Further features are stated in the dependent claims. The main part of the invention comprises the use of an electrically controllable fibre optic polarisation controller in combination with an FBG wavelength readout instrumentation system to measure the wavelength splitting of one or several wavelength multiplexed birefringent FBG sensors. The polarisation controller is either i) operated in a scanning mode to cover a wide range of
15 polarisation states in a certain time period, including the two orthogonal polarisation states corresponding to the minimum and maximum Bragg wavelengths, or ii) operated in a tracking mode with electrical feedback from the receiver of the instrumentation system to change the polarisation state in order to track the minimum and maximum Bragg wavelengths of each FBG sensor. The scanning mode can either use random scanning or a programmed sequential
20 scanning to cover a grid of polarisation states on the Poincaré Sphere. The measured minimum and maximum wavelengths provide a measure of the measurand induced birefringence, independently of the magnitude of this birefringence. The invention can in combination with a wavelength read-out unit with a proper wavelength reference system provide absolute measurements of both orthogonal Bragg wavelengths, which enables simultaneous
25 measurements of two independent measurements, such as temperature and pressure.

The invention can also be used to eliminate errors in FBG sensor measurements caused by the grating birefringence in combination with an interrogation system with a partly or fully polarised source and/or polarisation dependent components, independently of the magnitude of grating birefringence and degree of source polarisation.

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WO 00/77562

PCT/NO00/00208

5

Finally, the method provides a means for eliminating signal fading and optimise the signal amplitude of one or several birefringent FBG based two-polarisation fibre laser sensors.

Examples

5 The invention is described with reference to the illustrations, in which

Fig. 1a shows a preferred embodiment of a wavelength measurement device for demultiplexing and demodulation of several birefringent FBG sensor wavelengths based on a polarised wavelength swept narrowband source in combination with an automatic polarisation controller.

10 Fig. 1b shows one possible polarised wavelength swept narrowband source, based on a broadband source in combination with a tuneable optical filter and a polariser.

Fig. 2a shows a schematic illustration of the two orthogonally polarised reflection spectra of an FBG.

Fig. 2b shows the variation in measured Bragg wavelength of a birefringent FBG using a
15 wavelength readout system based on a polarised source in combination with an automatic polarisation controller which is operated in a random scanning mode.

Fig. 3 shows a preferred embodiment of a measurement device for demodulation of a birefringent two-polarisation DFB fibre laser sensor using an automatic polarisation controller to optimise the beat signal between the two orthogonally polarised laser modes.

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Fig. 1a shows a preferred embodiment of the wavelength measurement arrangement used for measuring the Bragg wavelengths of one or several wavelength multiplexed birefringent FBG sensors, based on a polarised wavelength swept narrowband source in combination with an electrically controllable fibre optic polarisation controller. The source can either be a tuneable,
25 polarised laser or a broadband source in combination with a tuneable optical filter and a polariser, as shown in Fig. 1b. The arrangement includes a reference system based on a fixed Fabry-Perot filter in a separate branch with a separate detector, in combination with a reference FBG. The reference fixed Fabry-Perot filter and the reference FBG should have very low birefringence, with a birefringence induced wavelength splitting of <1pm.

WO 00/77562

PCT/NO00/00208

6

The light from the polarised wavelength swept narrowband source (1) is passed through an electrically controllable polarisation controller (2), operated in either a scanning mode or a tracking mode to find the two orthogonally polarised reflection spectra of the birefringent FBGs with corresponding minimum and maximum Bragg wavelength, λ_{Bx} and λ_{By} , as illustrated in Fig. 2a. The polarisation controller can for example be ETEK's FPCR fibre optic polarisation controller, which is based on multiple liquid crystal cells to rotate the incoming polarisation state to any other state through a combination of electrical drive voltages to the liquid crystal cells.

Referring to Fig. 1, the transmitted narrowband light is splitted in two by a fibre optic directional coupler (3). The main part of the light is passed onto the FBGs (6), including at least one FBG (5) with known wavelength, providing an absolute wavelength reference, via another directional coupler (4). The reflected light from the FBGs, occurring in time when the wavelength and polarisation of the narrowband filtered source light matches the orthogonally polarised Bragg wavelengths of the FBGs, is directed through the directional coupler (4) onto a detector (7). A smaller part of the splitted light is transmitted through a polarisation independent fibre F-P filter (8) with fixed and known free spectral range, which produces a reference comb spectrum at the output with peaks having a constant, known frequency separation equal to the free spectral range to provide an absolute frequency/wavelength scale. The reference comb spectrum is passed onto a second detector (9). The signals from detector (7) and (9) are sequentially sampled, processed and compared in a signal processing and data presentation unit (10), providing accurate and repeatable information on the orthogonally polarised Bragg wavelengths of the FBGs. For each wavelength scan and subsequent wavelength measurement the polarisation state at the output of the polarisation controller is changed until the minimum and maximum wavelengths λ_{Bx} and λ_{By} are measured, as illustrated in Fig. 2b. In a tracking mode the measured wavelength is used to generate an electrical feedback signal to the polarisation controller which changes the polarisation state at the output until the maximum/minimum wavelengths are measured.

Fig. 3 shows a preferred embodiment of a measurement device for demodulation of a birefringent two-polarisation DFB fibre laser sensor using an automatic polarisation controller to optimise the beat signal between the two orthogonally polarised laser modes. Light from a

WO 00/77562

PCT/NO00/00208

7

pump laser (1) is launched through a fibre WDM coupler (2) via an optical fibre to generate lasing in one or several DFB fibre laser sensors (3) (the figure shows only one laser sensor). The generated narrowband laser light at two orthogonal polarisation states with a wavelength splitting $\Delta\lambda$, proportional to the measurand induced birefringence of the laser sensor, is directed through the WDM (2) via an automatic polarisation controller (4) and a linear polariser (5), onto a detector (6) to generate an electrical beat which is directly proportional to the measurand induced birefringence. The automatic, electrically driven polarisation controller (4), is either operated in a scanning mode to cover a wide range of polarisation states in a certain time period, or operated in a tracking mode with electrical feedback from the signal processing unit (7) of the instrumentation system to change the polarisation state, to align the two orthogonal polarisation states at 45° relative to the linear polariser (5) to maximise the electrical beat signal amplitude. It can also be cases where one is interested in minimising the electrical beat signal amplitude to generate single polarised laser light. This can be done with the presented method.

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PCT/NO00/00208

21-09-2001 09/926727

JC13 Rec'd PCT/PTO 10 DEC 2001

ART 34 AMDT

8

Claims

1. A method for measurements of the orthogonally polarised Bragg wavelengths of one or several birefringent fibre Bragg grating (FBG) sensors, using an FBG wavelength interrogation apparatus, being able to measure the reflected or transmitted Bragg wavelengths from an FBG sensor,

characterized in that the apparatus uses means for generating polarised light and uses at least one electrically controllable fibre optic polarisation controller, which is either operated in a scanning mode to cover a wide range of polarisation states in a certain time period, including the two orthogonal polarisation states corresponding to the minimum and maximum Bragg wavelengths, or operated in a tracking mode with electrical feedback from the signal processing unit of the apparatus to change the polarisation state in order to track the minimum and maximum Bragg wavelengths of each FBG sensor.

2. A method according to Claim 1,

characterized in that the polarised light is generated from a polarised laser source

3. A method according to Claim 1,

characterized in that the polarised light is generated from an unpolarised or partly polarised source in combination with a polariser

4. A method according to Claim 2,

characterized in that the FBG wavelength interrogation apparatus is based on a tuneable polarised, narrowband laser

5. A method according to Claim 3,

characterized in that the FBG wavelength interrogation apparatus is based on a broadband source in combination with at least one tuneable narrowband optical filter and at least one polariser.

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PCT/NO00/00208

21-09-2001

ART 34 AMDT

9

6. A method according to one of the Claims 1 to 4,

characterized in that the fibre optic polarisation controller is based on multiple liquid crystal cells to rotate the incoming polarisation state to any other state through a combination of electrical drive voltages to the liquid crystal cells.

7. A method according to Claim 3,

characterized in that the FBG wavelength interrogation apparatus is based on a broadband source in combination with an unbalanced interferometer for converting wavelength variations to measurable intensity variations, and at least one optical filter for selecting the individual FBG sensors.

8. A method according to Claim 3,

characterized in that the FBG wavelength interrogation apparatus is based on a broadband source in combination with at least one edge filter for converting the sensor wavelengths to measurable intensities.

9. A method for eliminating signal fading and optimise the signal amplitude from each of two orthogonally polarised, slightly different laser wavelengths of at least one birefringent, dual-polarisation fibre Bragg grating (FBG) based fibre laser sensor where laser light at the two orthogonally polarised eigenstates from at least one fibre laser sensor and is passed through at least one linear polariser and mixed in at least one detector, generating at least one electrical beat frequency which is a measure of the birefringence induced in the laser sensor by the measurand,

characterized in that an electrically controllable fibre optic polarisation controller, which is either operated in a scanning mode to cover a wide range of polarisation states in a certain time period, or operated in a tracking mode with electrical feedback from the detector signal to change the polarisation state, is used to align the two orthogonal polarisation states relative to at least one linear polariser to either maximise or minimise the electrical beat signal amplitude.

AMENDED SHEET

PCT/NO00/00208

The Swedish Patent Office
PCT International Application

ART 34 AMDT
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10. A device for carrying out the measurements of two orthogonally polarised Bragg wavelengths of one or several birefringent grating (FBG) sensors as given in claim 1, using a wavelength spectrometer based on a light source (1) covering all wavelengths of interest, including

- at least one wavelength selective element,
- means (3) for directing the light from the source to the fibre Bragg grating sensors and
- means (7, 9) for directing the reflected or transmitted light from the fibre Bragg grating sensors to at least one detector, and
- circuits (10) to compare the detected signals from the light source (1) and the fibre Bragg grating sensor (6), to provide information on the orthogonally polarized Bragg wavelengths, **characterised in that** the device comprises at least one electrically controllable fibre optic polarisation controller (2) receiving light from the light source (1), where the polarisation controller is either operated in a scanning mode, or in a tracking mode with electrical feed back from the signal processing unit of the device, to change the polarisation state in order to track the minimum and maximum Bragg wavelengths of each fibre Bragg grating sensor (6).

WO 00/77562

PCT/NO00/00208

1/3

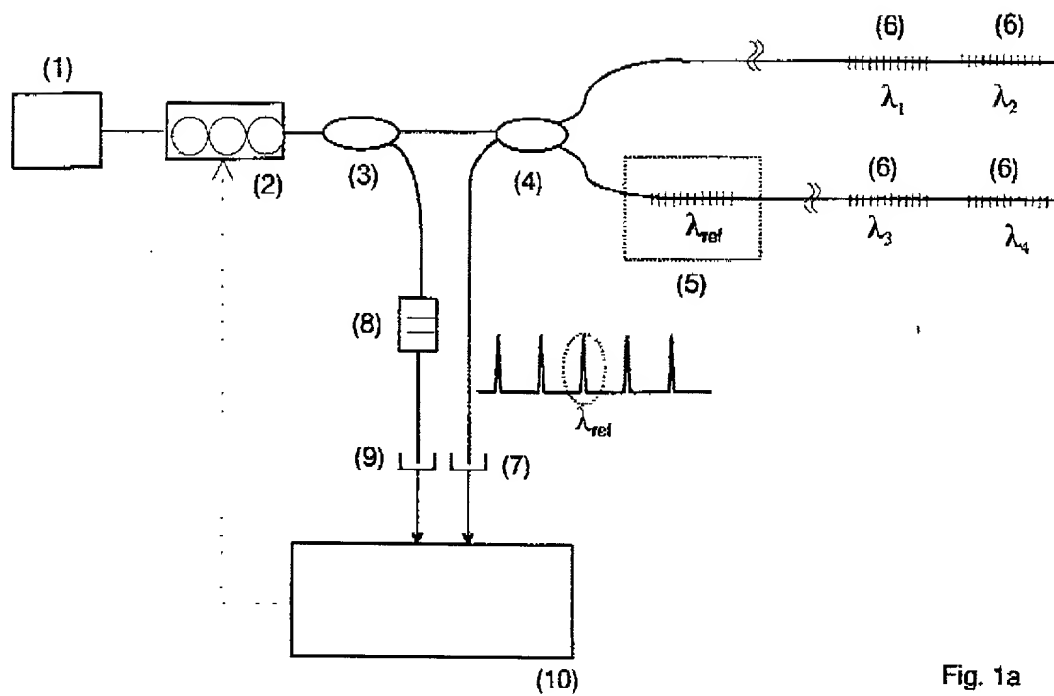


Fig. 1a

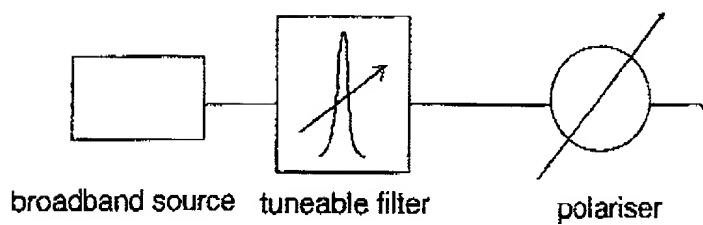


Fig. 1b

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WO 00/77562

PCT/NO00/00208

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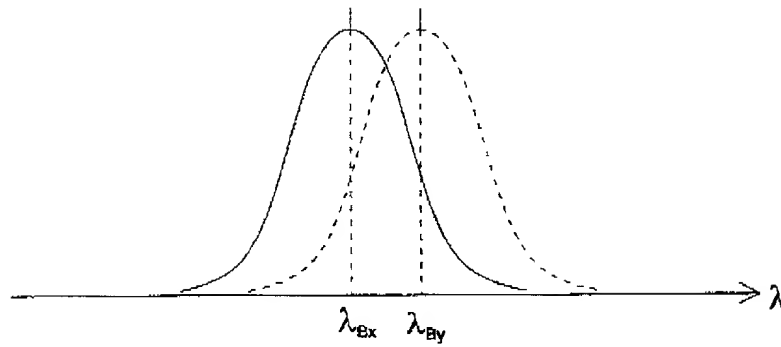


Fig. 2a

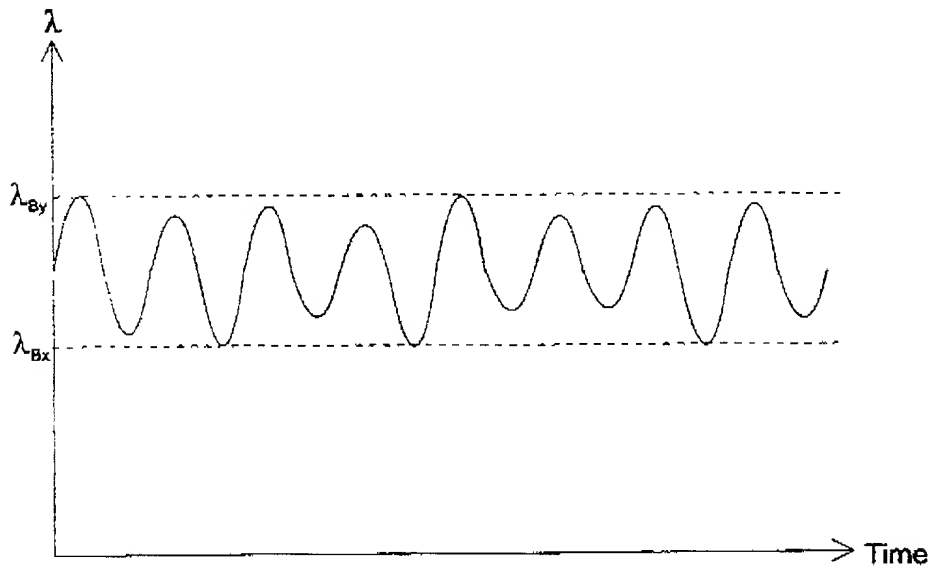


Fig. 2b

WO 00/77562

PCT/NO00/00208

3/3

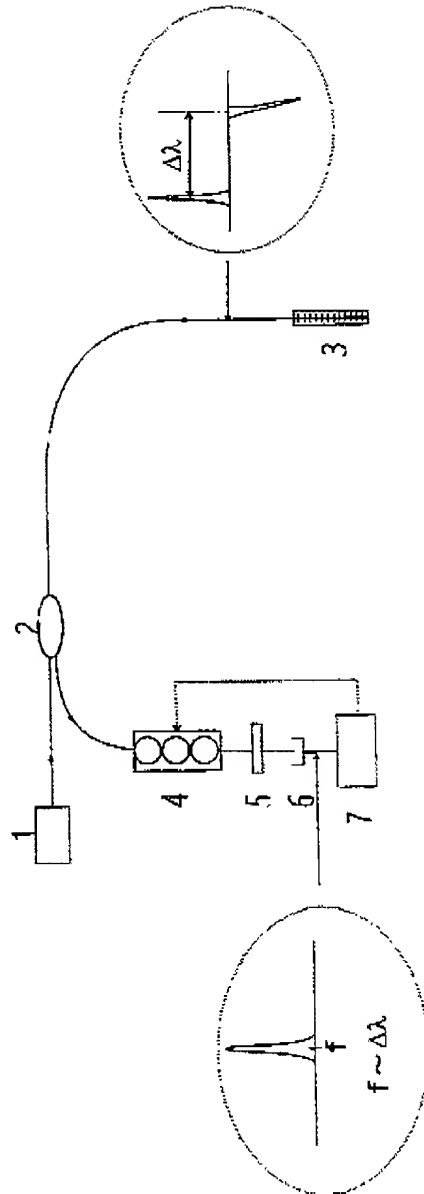


Fig. 3

DECLARATION FOR PATENT APPLICATION

Docket No. _____

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled _____, the specification of which

(check one) _____ is attached hereto.
 _____ was filed on _____ as
 Application Serial No. _____
 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Claimed
19992912	Norway	15.06.1999	X Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	
			___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	
			___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	
			___ Yes ___ No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PCT/N000/00208	15.06.2000	
(Application Serial No.)	(Filing Date)	(Status-patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status-patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Donald L. Dennison Reg. No. 19920
 William H. Meserole Reg. No. 20833
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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